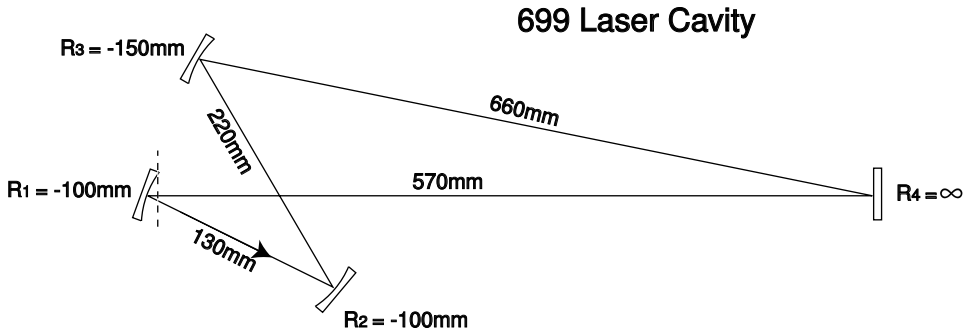
Phys 532/822 Assignment 3 Due February 18

In this homework, you will work out various properties of Model 699 laser from the Coherent Laser Corporation. This is intended to practice what we have learned about cavity with a real laser. Model 699 is a typical commercial ring laser, the cavity in this laser consists of four mirrors in a "bow-tie" configuration, as sketched below,



1. **Stability of the 699 Cavity:**
   (a) Show that the cavity as shown is optically stable.
   (b) Find the range of values R_1 could take such that the cavity remains stable.
   Hint: assume that the angles of incidence on the mirrors are small enough to be paraxial. To calculate the round trip matrix, you are suggested to start with M_1, that is, use the plane just before M_1 as the reference plane, as shown in the figure; also use a computer to do it.

2. **Modes of the 699 Cavity:**
   (a) Find the Gaussian beam mode of the 699 laser cavity. In particular, locate all the positions in the cavity at which a focus occurs, and determine the beam waist at each focus. Assume a wavelength of 800 nm.
   (b) In this laser, the mirror labelled R_4 is only partially reflecting, to allow a fraction of the circulating light to escape. What is the divergence angle of the output beam?

3. **Mode Frequencies of the 699 Cavity:**
   Find the free spectral range ν_F and the round-trip Guoy phase shift $\Delta\zeta$ for the 699 cavity. (Ignore any phase shifts due to he mirrors.)

4. **Linewidth of the 699 Cavity:**
   If mirrors R_1, R_2, and R_3 of the 699 cavity have (intensity) reflectances of 99.5%, and mirror R_4 has reflectance 95%, calculate the linewidth $\delta\nu$, the finesse $\mathcal{F}$, the quality factor Q, the photon lifetime τ_p, the loss per pass Γ, and the distributed loss coefficient α for the cavity.